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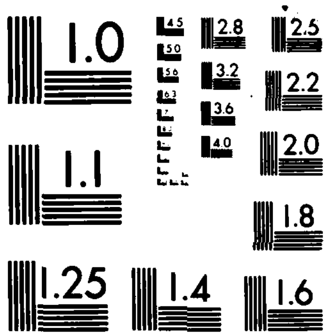

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AD-A141 306

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AUTHOR: Dan Neely, Capt, USAF, 1984

TITLE: SYSTEMS DEVELOPMENT AND APPLICATIONS SOFTWARE FOR MEDICAL FACILITIES

18 pages

DEGREE AWARDED: Master of Arts, Computer Science

Ball State University, Muncie IN

ABSTRACT

This paper is divided into two main parts, the historical part and a section on current trends and applications. The historical section looks at the period of developent between 1964 and 1974. It presents comonly accepted notions of that time regarding definitions objectives, functional requirements, and reasons for successes or failures in implementing of computer systems for hospital information systems. The second part of the paper looks at current trends and current applications in some representative areas. The paper is by no means comprehensive or completely representative in this subject, but rather attempts to provide an idea of what is happening in the medical field and where we can expect developments to lead.

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RESEARCH TITLE: Systems Development and Applications Software in Medical Facilities

AUTHOR: Daniel R. G. Neely

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RESEARCH PAPER

SYSTEMS DEVELOPMENT AND APPLICATIONS SOFTWARE

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by

DAN NEELY

15 MAY 1984

C S 589

DR. CLINTON FUELLING

BALL STATE UNIVERSITY

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Over the 10 year period from 1964 to 1974 a variety of computer applications in medical care has been developed within many US and European hospitals. In the first half of 1973, there was not yet in existence a single completely computerized hospital informatio system, although much progress had been achieved in utilizing the computer for many inpatient and outpatient services. It was predicted in the early 70's that the 1980's would see every patient and every doctor in any US hospital having more than 200 beds directly interfacing a computer almost daily.(COLL74). Indeed, with the great reduction in hardware costs and the resultant proliferation of micros, this prediction has been surpassed. The advent of micros and micro networking, time sharing enterprises, the minicomputer, and the dramatic reduction in hardware costs, all coupled with the sophisticated software packages available today, have resulte4d in this prediction being surpassed to the point of computer use in virtually all hospitals and a majority of outpatient clinics.

DEFINITION OF HOSPITAL COMPUTER SYSTEM.

During this period of development, a very good approach to development was taken. First of all, there was a common, generally accepted definition of a hospital computer system. It was " a system that utilized electronic data processing and communications equipment to provide on line processing with real time responses for patient data within the hospital and its outpatient department including ancillary services (laboratory, pharmacy, x-ray, etc.) (coll74). Administrative computer systems, handling admissions, bed census, menu planning, patient schedules for ancillary services, and finances, were conceived of as subsystems to the hospital computer system(HCS). Similarly laboratory computer systems, x-ray, pharmacy, and the like were looked at in a similar light.

This early thinking was very sound as far as it went, but the HCS definition was somewhat narrow in scope, as will be seen later. Commensurate with this accepted definition there evolved an accepted list of objectives for HCS's. They were: (COLL74 et al)

OBJECTIVES FOR THE HCS

1. Improved quality, quantity, utility, and speed of medical data communication while at the same time containing costs.

2. Communicate individual patient data from the professionals providing medical care (doctors, nurses, technicians) into the computer medical record and then to other professions (dietician for example) and hospital service departments (ancillary services).

3. Communicate patient data from subsystem components (eg automated multiphasic screening laboratory or intensive care unit) into the patient's computer medical care record.

4. Communicate between clinical services (ie nursing stations) and ancillary services (eg ECG or radiology).

5. Establish scheduling and booking files and communicate such information for patients, personnel, and medical care services.

6. Establish a data base for administrative and business functions.

7. Establish a medical data base which can support clinical and health services research.

8. Assist in the teaching of medical staff and medical students in the health education of the lay public.

9. Provide data necessary for projection of health care needs and planning for hospital and medical services, not only for the hospital itself, but also for the community.

Although these obvjectives were thought of as 'immediate', some have been more immediate than others, at least in terms of the degree of sophistication, and degree of use. The first 6 have progressed the farthest, while 7,8, and 9 can be found in various stages of developmnent design, and implementation. The first 6 are designed and implemented in a variety of schemes in many facilities throughout the US and Europe (SHAN79).

FUNCTIONAL REQUIREMENTS OF THE HCS

Commensurate with a definition of a HCS and its desired objectives several functional requirements were identified and commonly accepted. They were:(COLL74)

1. Provide data quality control programs and procedures to reduce

errors of patient identification and minimize instrumental and human errors throughout all HCS subsystems. It must be able to provide more complete data

and/or more selective data for each user's needs, increasing the utility and legibility of printouts by emlpoying human engineering factors. It should increase the speed of communication of data between data sources and data users.

2. For each patient, on a continuous 24 hor a day basis, capture at the source, on line if necessary, all inpatient and ourtpatient service data, and store in the patient computer record the following essential information:(a) selected history, physical examination, and progress report data which is quantitated or susceptible to some standardization of terminology and formatting of input; but the system must be capable of handling natural language as necessary; (b) all diagnoses;(c) all diagnostic interpretations from x-ray, ECG, EEG, pathology, and other physician reported examinations; (d) doctors' orders; (e) all procedures, including operations, deliveries, etc; (f) all clinical lab test results; (g) essential summarized patient monitoring data from intensive care areas; (h) all drugs admisistered in the hospital and dispensed in the outpatient pharmacies; and (i) ancillary services provided to patients (ie services supporting the healing or diagnosis process).

3. To provide any appropriate part or all of this data, on demand and when necessary, in the form of printouts or visual displays to (1) the physicians for patient care, and (2) the administrative and business offices for patient accounts, statistics, etc.

4. To provide admisistrative communicative functions such as (1) scheduling of patients and procedures, including outpatient appointments and registration; hospital admissions, bed census, and scheduling for ancillary services; (2) to provide scheduling and control functions for personnel, supplies, and equipment, including hospital staffing, inventory control, menu planning, automated equipment quality control, etc; (3) to provide message switching functions to multiple departments(eg lab test orders to and from nursing station to lab, to medical chart room, and to computer center) and (4) to provide business functions including posting of changes, billing, payroll, etc.

5. To provide a data base for (1) investigators needing both patient and statistical files for clinical, epidemiological, and health services research; (2) admisistrators for hospital services evaluation, simulation, projection, and planning; and (3) medical education.

6. To satisfy confidentiality, security, and legal requirements.

As we can see, the early thinking in this area had some very good forethought and covered a wide range of considerations, many of which are conducive to current capabilities of systems analysis and data base management systems. In addition to a definition, objectives, and functional requirements of a HCS, much consideration was given to personnel, equipment and software, system reliability and backup, ant utility.

PERSONNEL NEEDS

The highly specialized nature of data processing was recognized and assigned appropriate significance. Clearly this is seen in the amount of consideration given to identification of key personnel functional descriptions within the HCS support staff.

One of the first positions to be considered in any such operation was the 'project chief', responsible for overall development, control, etc.

In these early years of development, there was an InordInate amount of emphasis that key personnel have an in depth knowledge of the medical field so that they may maximize the effectiveness of thier positions. For example, a common conception of a project chief would be a person highly qualified in medicine and engineering or computer science. A 'physician-engineer' as it were, would be a MD trained in engineering, biophysics, or computers.(COLL74) It is generally recognized today that computer science is a profession in its own right, and key positions in the field do not require experience or training(in applications to be automated) to effectively fill those positions.

Further examples of tis are seen in descriptins of systems supervisors and informatiion engineers who should have a background in the life sciences. Further, a requirement is identified for medical systems analysts, who should be trained in analysis of medical subsystems. Finally, applications programmers ideally would come from within the orgainzation. It was highly desirable to train pharmacists, lab technicians nurses, and physicians to function as programmers or to work closely with the programmers in their particular applications.(COLL74)

Although there is nothing wrong with wanting those qualities in DP staff, it is highly unlikely that it could be achieved today to any appreciable degree. Indeed, many of the professions indicated, namely pharmacists, physicians, and nurses, could not be bothered with such

detail interfering with their primary functions. This, as much as anything, has influenced the systems analysis approach where DP personnel interview hospital personnel to get specifications for design of systems. Again, data processing is recognized as a distinguished profession that has come of its own, and is completely capable of providing service when called upon to do so.

The orientation and training of personnel was addressed early, and addressed effectively. For example, it was recognized that procedures previously handled on an informal basis would now require formal definition. This had to be identified in the analysis phase of systems development. Much emphasis on meetings and discussions between DP staff and department representatives at all levels was seen as essential to the successful development and implementation of systems. Of course, not always was this recognized as important. As with any other professional endeavor, much was learned in hindsight.(SOHN79 et al)

DATA MANAGEMENT FOR THE HCS

The need for a data base manmagement system was identified and functionally defined long before DBMS's were commercially available. It was determined that small collections of patient data from subsystem components, (subsystems to the HCS) ie blood banks, laboratories, bed censys, etc, would never staisfy the requirements of clinical services or management. Collections of this data into menaingful summaries and reports had been carried out in much detail by manual means for many years. It was seen as vital to clinic services and administrators that it be continued and improved.

Accordingly, to satisfy handling many forms of medical information for many visits through time, it became necessary to have an integrated, variable length, variable format, computer stored medical record. It was deemed necessary to store data in a structure which permits retrieval of all or any specified portion of an individual patient record in (1) time oriented sequence, in chronological order by patient visit; or (2) source oriented sequence, by services, and/or ; (3) patient medical-problem oriented sequence. Additionally, management needed monthly, quarterly, and annual statistical summaries in a variety of formats.(COLL74 et al)

HARDWARE NEEDS FOR THE HCS

During this period of time, the micro computer was not yet a marketable reality. Therefore the concepts of hardware support and configurations were rather limited, in comparison to today's capabilities in small machine processing power and advances in true networking capabilities.

With the data base requirements defined as they were, the most commonly accepted hardware configuration was to use a mainframe with large core memory and processing power as the core of the HCS, and a minicomputer to integrate HCS subsystem modules. Because HCS's had as a basic requirement high reliability on a 24 hour a day basis, sufficient redundancy of equipment was necessary to insure this capability. Additionally, storage devices needed to be of sufficient size and speed to support on line acceptable rssponse times from a large and varied data base. Two levels of storage devices were seen as required for the data base itself: (1) mass direct access devices, with less than one second random access time to any active, medical file for all personnel authorized to use the HCS, and (2) tape devices for archival storage of inactive files, backup, and batch processing.(COLL74 et al)

The only other peripheral devices considered were terminals and dedicated minicomputers. The mainframe had to have the capability to handle a large number of terminals on line, so that patient visits, ancillary services transactions, etc could be entered as they occured. Depending on the nature of the transaction, some response times would have to be slower that others. For example, on line monitoring of patients in intensive care units would have a high priority response time in comparison to, say, a pharmacy transaction.

Minicomputers were seen as handling peripherals, storing display formats, laboratory quality control processing, and 'high density data generators' for applications like intensive care units and quality control monitoring of large automated chemical analyzers. The idea here was a hardware configuration which would model the orgainzation of the operation in a functional sense. The mainframe would handle the bulk of the routine patient care and admisistrative functions, while specialized mini's would support subdivisions of the hospital like ancillary services, special clinics with high volumes of data, etc. They also would manage the 50 to 100 terminals visioned as necessary in a 200 to 300 bede facility. (COLL74)

There were many other considerations given to computer support in medical facilities. Software requirements, systems reliability, cost guidelines, utility requirements, controls on privacy and

confidentiality, quality assurance of date, timing of implementatin, schemes to implement integrated subsystems one at a time as money allowed, etc. These reqiuirements were presented in as many different ways as there are books on the subject. Among them, there were as many successes as failures, which has served to improve the success ration and decrease costs in more recent attempts to implement and design systems. It is beneficial to examine some of the common characteristics of systems which succeeded, as well as those that failed.

REASONS FOR SUCCESS OR FAILURE

The reason most often cited for failure of HCS's during this period was a suboptimal mix of medical and computer specialists(COLL74 et al). Generally, the project staffs were comprised of well motivated physicians with little computer experience, coupled with computer and systems experts relatively naive to the intricacies of the overall medical profession. The barrier to communication between These two highly technical, complex professions led to the DP staff underestimating vast medical needs. Primarily due to a lack of sufficient understanding of the total environment in detail, systems developed fell dreadfully short of functional requirements.

A second contributor to failure was a lack of financial long term commitment. This happened not as a result of a reluctance by management to invest in systems, but in a gross underestimation of costs to implement and sustain such complex, integrated subsystems. Several projects were terminated after 3 to 5 years of time and several million dollalrs were invested, only to have a system still far from completion(COLL74).

Integration of subsystems was another problem. Several HCS projects demonstrated great success in implementing subsystem components for administrative, laboratory, bed census, patient scheduling, or pharmacy operations for example. When the next step was to integreate these subsystems, suddenly serious incompatibilities were seen between the various modules and data files. The remedy was major reprogramming at astronomical costs to achieve an integrated patient file. The usual response at this point was to comprimise and settle for these independent subsystems. Manual procedures then had to be developed to integrate any data in a meaningful way(COLL74).

Many systems failed because of unacceptable input schemes. Physicians who were faced with key board terminals just would not accept such means for communicating with the computer, and clerical type personnel were called upon to support input. As a result,

later efforts were directed toward touch wire or light pen input, which were more acceptable to physicians. Also, alternative schemes to minimize direct physician interface for input were introduced (SCHM79).

Essentially, any analytical approach to systems development, design, and implementation that is modeled after successful schemes of project development, with emphasis on avoiding the above mentioned shortcomings, will have much potential for success.

There are two philosophies that seem to prevail to develop a good system. (PRIE82) One is to get people on the DP staff and development team who are dual professionals, having computer science as well as medical knowledge. The reality of this approach is that it is exceedingly difficult and expensive to identify that kind of a professional. In light of the degree os sophistication seen in structured analysis and structured design in more recent years, it makes an alternative philosophy for systems development very attractive. Indeed, the failing mentioned above was not really due to a lack of medical competency on the DP staff, but to a lack of in depth, detailed understanding of the system to be automated. Achievement of that understanding, along with several other goals, is precisely what structured systems analysis is all about.

Another goal of systems analysis is to present a realistic, long term picture of a timetable of systems implementation along with associated costs. A detailed proposal must be presented clearly and completely, so that management has an accurate idea of what is needed, and what they can reasonably expect to invest totally as well as incrementally.

This commitment must be obtained early in the project, and for a large facility, 3 to 5 years to complete a total system is not unreasonable. In reality, because the medical field is so dynamic, it is rather naive to expect a system of this size to ever be completed as originally specified, or to ever reach a static state. Changes in policies, medical standards of excellence, laws, etc will forever influence the structure of any system so involved as an HCS.

An integrated, modular system is fundamental. Because that is so, integration and compatibility of subsytems must be in the plans from conception. Because of the many and varied sources of potential input to a complete patient record, it is believed that the implementation of one common central data base of integrated files is essential.(PRIE82) Small collections of patient data from subsystems on dedicated small computers for the lab, blood bank, admissions, etc, have

been demonstrated as falling well short of functional requirements of HCS's, as previously indicated.

There are still many different opinions on where to begin in the implementation of modular subsystems, with the ultimate goal of a fully operational HCS. Probably, a few schemes on the order o implementation will emerge as most common, most successful, or least expensive.

Although the environment of medical care and administration of such an environment is highly complex, technical, and fraught with variables, the tools and heuristics of structured analysis, design, and implementation are just as applicable to this environment as any other. Clearly, the need for a highly detailed analysis of how things are done is essential. Hours and hours of interviewing users, middle and upper level managers, medical technicians, and nurses, as well as physicians, ancillary services technicians, and so on, are critical to design success. This type of analysis is fundamental to structured analysis (DEMA79 et al).

CURRENT EXPANDED DEFINITION

In any endeavor, as progress occurs terminology changes to reflect that progress. The evolution to HCS's has not been immune to these transformations. An example is that HCS's are no longer referred to as such, but are now called Management Information Systems(MIS), a more general term given to a more general definition than that of an HCS. A MIS can be, and in reality is, both manual and automated. MIS generally implies "computer", but only to the extent that the computer is one tool used in achieving a total MIS. (PRIE82)

Many people conceive of a MIS as a data base with all information in one area. This is certainly a logically desirable concept in principle. In fact, what is found is several unique and separate MIS's within a facility. Although total integration is still a goal, it has yet to be achieved to a great extent.

This more current thinking on the notion of a hospital information system draws on previous requirements, but is broader, in that it sees a MIS as extending beyond the computer and serving a wide and varied type of user, at different levels in the management system. (PRIE82)

MIS's can provide information to executives for strategic planning and decision making. It provides supervisors and first level managers with a method for structuring procedures to contain costs and minimize procedural turnaround time.(PRIE82 et al)

As mentioned earlier, although total MIS integration is still a goal, it is seen as more and more elusive primarily due to the impractical and unrealistic constraints of cost, time, and effort to develop. The diversification and idiosyncracies of department needs often make reduction of all data into one integrated data base very difficult. However, in many related areas such as accounting or nursing, significant inroads toward integration are being made. (PRIE82)

This portion of the paper has presented much of the early thinking that went into developing functional requirements, objectives, and definitions of hospital information systems. Also there has been some comparison and contrasting of these early ideas with present day philosophy. This then serves as a demonstration of where these systems have been, and where they now hope to go. The next part of this paper will discuss specifics about current applications and applications under development.

CURRENT APPLICATIONS AND TRENDS

The relatively low cost and flexibilty of microcomputers has gretly encouraged their wide use in hospitals. The Air Force Medical Service is as enthusiastic as the civilian sector in capitolizing on these applications with the ultimate goal of a hospital wide, integrated MIS. The USAF Regional Hospital Sheppard, Sheppard AFB, TX has placed micros in some key areas as pilot applications for an eventual MIS. (HOSP83, July, "Budding Applications, p81)

CLINICAL LAB

calculating and evaluating quality control within the clinical laboratory is an essential measure of the credibility of the laboratory. this is traditionally a laborious task, requiring massive amounts of paper storage to support accreditation. The quality control program at Sheppard calculates, evaluates, and stores all quality control data for the clinical isotopes section. Software allows the hospital to accomplish this daily. The system has a tremendous enhancement over the traditional method in that via a modem, Sheppard can link with the vendors mainframe and immediately compare its quality control data with other hospitals doing similar procedures with the same methodologies and instruments. Identification of trends allows the hospital to take immediate corrective action.

Another area of growing interest is the use of artificial intelligence for evaluation and report of clinical lab results. Great potential for direct benefit

of the quality of medical care is anticipated here. At present three programs are being used at Sheppard, with extensive development plans for the near future.

One program calculates and reports protein electrophoresis for patients records highlighting whether results are within normal limits. Expansion plans will include a clinical interpolation. A second program

calculates, clinically interprets, and reports a dexamethasone supression test for diagnosing endogenous depression. A third AI application that can evaluate and clinically interpret coronary artery disease will have a trial run soon. Besides realistically evaluating the probability for developing coronary artery disease, the program can educate as to the effects of smoking, high blood pressure, family history, and fat intake.

Other applications at Sheppard in planning or development phases are 1. inpatient pharmacy system to track inpatients, prescribed medications, and administration regimens. 2. a medical training program to monitor personnel training currency and produce reports. 3. a quality assurance program for plant management personnel to better monitor the quality of housekeeping services. 4. a prosgram for food service to cost out food inventory. 5. a personnel management program to maintain a data base of assigned vs. authorized personnel and produce reports.

PERSONNEL RECORDS

The Hospital Corportation of America(HCA) is pilot testing a distributed data processing system for hospital personnel record keeping that will place stand alone dedicated minis in individual departments. (HOSP83, July, "Human Resources Management", p85)

The data processing system, called the personnel distributed system, is expected to help hospitals examine each department's role. This reexamination could lead to a reallocation of functions and tasks to take advantage of available capabilities and personnel in the hospital.

NURSE STAFFING

The problem of nurse staffing structure is indeed a difficult one in hospitals. The goals are to maximize care and productivity with the minimum amount of staff. Historically this need has been difficult to meet because of the many varialbles and little time to consider them. Patients on a given ward vary from hour to hour in their care requirements, while nurses available on a shift can't

always handle the load. The response to this is a float pool, maintained to make ad hoc adjustments to difficult situations, which are little more than stopgap measures. A program called SNAP (simplified nursing allocation program) refines this response. (HOSP83, July, Computerized Nurse Staffing' p90).

SNAP calculates the amount of care provided each patient in minutes of nursing time. To do this, it requires a patient classification system in time values. Additionally, it matches nurses to patients, sends hours reports to the business office, and manages the float pool. SNAP helps ease the difficult task of continually adjusting staffs to variable patient loads. It is accurate, timely and fair. Its reporting system helps minimize overstaffing, understaffing, and interpersonal problems often generated under these conditions.

MEDICAL DEVICE DATABASE

The American Hospital ASsociation's (AHA) National Data Network was expected to complete pilot usage of its Medical Device Database(MDD) in September and to be available to 50 hospitals on a limited basis, before opening up to an anticipated 1000 hospitals by the years end. MDD is designed to provide hospital purchasing agents with immediate access to a spectrum of device and product information.(HOSP83, Sept, 'Device Database Readied for Core Group Use' p58).

The MDD currently has information on 50,000 devices and supply items from some 7000 vendors. Access is via terminal and modem. Product information is stored at 3 levels. The first level includes all major product categories, eg forceps. The second level subdivides into various types, eg hemostatic forceps. The third level information includes information on specific products, such as manufacturers, vendors, order numbers, order quantities, units of issue, and list prices. It is online 24 hrs a day, with user charges computed hourly.

ANESTHESIOLOGY

There are many areas of health care delivery that require frequent annotation to a record of a number of varialbles, for both clinical and legal reasons. The intraoperative anesthesiology record log is one of these areas. The quality of this record can be critical, but it may be degraded by stresses on the anesthesiologist, or entries may be omitted or important changes overlooked during periods of boredom. The Crawford Long Anesthesia Record System (CrawLARS) offers a solution to these problems.(PMT84, p27).

CrawLARS acquires and plots vital signs through standard medical monitoring devices. The anesthetist enters drug doses and other information via a keyboard. CrawLARS generates a compact, multicolor anesthesia record.

The system consists of a HP 9826 micro, eight color flatbed plotter, data acquisition and control unit, four channel patient monitor, and automated sphygmomanometer. Additional monitoring equipment may be added.

The entire system is on a portable stand, to be moved from room to room as needed.

Completely automated data acquisition is available for two direct pressures, indirect arterial pressure, heart rate, and temperature. Automated vitals alone markedly reduce anesthetist time devoted to record keeping. The keys on the keyboard have been relabeled to streamline manual data entering. The technique for drug input is slightly faster than pen and paper.

Clinical response to CrawLARS has been favorable. Most anesthetists feel it is a significant improvement over manual records keeping. The legibility of the record is particularly well received. Color coding is seen as a definite plus. Automatically displayed prompts help free the anesthetist from having to remember the details, so he may devote more time to direct patient observation.

ARTIFICIAL PROSTHESIS

In another area, the computer is being used to design computer produced artificial joints for hip replacements, etc. At the Hospital for Special Surgeries(HSS) in NY city a computer aided design and manufacturing system (CAD/CAM) was developed which is revolutionizing custom joint replacement.(HOSP84,Jan 1, p43).

The system, licensed to the orthopedic division of Johnson and Johnson, in New Brunswich NJ, is accessed via terminal. The prosthesis selections software package called CAPS should enable surgeons across the country to design implants tailored to their patients' needs.

The system has a data bank stocked with implant designs. It can "read" x-rays, via the surgeon's use of a lighted screen and pointer to enter patients x-ray data. The surgeon can then manipulate a suggested prosthesis image to create a fit within the limits of acceptable design.

Next, a 'blueprint' of the implant is encoded on paper tape and passed to the computer assisted manufacturing (CAM) portion of the system. CAM is capable of producing a device in 75 minutes, which is a great improvement over the 2 days required by a skilled machinist.

Ten to fifteen percent of patients fitted with a traditionally designed prosthesis for the 'average' patient results in a failure. Surgeons have been forced to specify implant parameters verbally and by sending x-rays via mail. Most surgeons lack the expertise to approve complex blueprints. Now they have an alternative.

CAD/CAM produced joints should wear longer and give a better fit. Hospitals accessing this system will better meet the needs of difficult or unusual cases. Some prostheses, like artificial knees, are costing as much as $4500 to produce. CAD/CAM will produce one for less than $3000. In the next three years, the system will be accessed by as many as 100 hospitals having major ortho services.

ANESTHESIOLOGY

Various anesthetic agents, acting simply or in combination with other agents, are known to increase the likelihood of cardiac arrythmias. Unfortunately, during surgeries, the anesthetist rarely has time to study these as they occur, and is only able to note them as they occur in fleeting moments on the patient monitor(MEDI83, p131). A microprocessor based arrythmia monitor/recorder system has been developed to record those events. This system will eventually compile enough data to provide two things: (1) arrythmia trend plots, and (2) a database of arrythmias on which to evaluate detection algorithms.

This system, at the time of writing, had monitored 11 operations, totaling 20 hours, so that any conclusions would be premature. Initial tests have, however, demonstrated the system to be reliable in recording events when compared against the traditional means used to capture such data. Some shortcomings are yet to be worked out in building the database mentioned above.

PATIENT INTERVIEW

One of the most common criticisms of computers from laypeople is their impersonal nature ie a machine communicating with a person. At Beth Israel Hospital, Boston, a program designed to take a medical history from patients being seen in the ambulatory care clinic is perceived as less threatening and intimidating than the

same type of interview conducted by physicians. With a computer conducted interview, the patient feels as if he is in control(HOSP83, Aug 16, p59).

The program's questions and dialogue are designed to give a personal touch to the session. It asks for permission before calling the patient by his first name. As questions are asked, it goes back and restates and summarizes answers to insure the correct data is taken. Questions can be repeated or skipped, and the interview proceeds at the patient's pace. The entire process takes about 30 minutes, and is generally well received by patients.

DIAGNOSES

In the area of aiding in making or confirming diagnoses, the computer is beginning to be a valuable tool. An experimental computer imaging technique under development at NASA's cell image lab in Houston is intended to aid in the early detection of squamous cell carcinoma. The key to surviving lung cancer is early detection. Undiagnosed, it can take 20 to 30, years to develop. The problem is that it is very difficult to identify early. The computer can help in this area(HEAL83, p1).

The indicator may be only a single cell, identified in a sputum sample. In clinical trials, the system has been given a 90 percent plus accuracy score. The system is slated for widespread use by 1988, but any hospital having suitable graphics imaging hardware and software could use the procedure now. The computer 'views' a digitized image and compares that against a known set of characteristics. The test is safe, inexpensive, and non-invasive, consisting of the patient providing a sputum sample. The sample is prepared on a slide to be viewed under an on line microscope, with the image display on a monitor. The monitor enables editing of extra cellular debris, leaving a clean image to be stored on tape.

Since the human body can be reduced to a collection of cells, the potential applications for image analysis and diagnosis are virtually limitless.

VA SYSTEM

In addition to applications development for particular functions within a hospital, much effort is still concentrated on hospital wide systems development, and the standardization of those systems. A recent example is the Vetrerans Administration's acquisition of $62 million in hardware, including some 300 computers.

This equipment will be installed in various facilities to imlplement systems designed for expansion, to initially support departments of medicine, surgery, admission and discharge, pharmacy, x-ray, and lab. There are six regions of jusridiction for the VA hospital system, and each will have its own software development and support branch.(HEAL83, December, p1).

Small facilities will have access to databases of patient profiles, requiring approximately 80 meg of disk storage, while larger facilities will be using 1200 meg systems. The language, mandated by VA as required to be used at all sites is MUMPS. This insistance on a common language is to foster portability of software between facilities.

The MUMPS language was originally developed by a group of physicians in 1967 at Massachusetts General Hospital(HEAL83, Dec, p22). It is currently used by over 4000 medical, commercial, and industrial installations. It has many attractive features. First of all, it was developed with medical applications in mind. It has the dual capability of functining as a programming language and a data base management system, and it is ANSI standardized. It is distinguished by file management techniques that reduce the amount of hardware requirements typical of other languages. It also is shown to use a lesser amount of code than other languages to perform a given task. The level of user friendliness enables "non-programmers" to write their own applications (HEAL83, Dec, p22).

In Good Samaritan Hospital, Downers Grove, IL, a very extensive patient care system is up and running. The system supports registration, treatment, and admission within minutes of a patients arrival at the hospital. Concurrently, nursing units, and ancillary services are alerted, based on doctors orders, and a patient record is created or updated if he has been there previously. Information for several administrative departments is also updated. Probably one on the single most significant advantages to this system is that everyone in the facility has the same information on the patient(ie every record has the same spelling of his name, same diagnosis, same admission date etc) greatly reducing conflicts in records. This information is stored for later retrieval should the patient ever return.(HEAL84, Jan, p75).

NETWORKS

In addition to emphasis on developing applications within a facility and systems to serve an entire facility, there have been some recent developments in network services to meet common needs of a group of community

hospitals, or on a nationwide basis. Several networks are now publically available which are providing medical bibliographies, textbook style data, and admisistrative information.(HEAL84, Feb, p1).

A network connecting 51 hospitals under the name Association of University Affiliated Programs(AAUAP) is linked and operating under the name MED/MAIL. United Health Care Corp(UHCC) is a natinwide group of 15 regional hospitals, performing a very similar service to AAUAP. These systems are essentially electronic mail operations used to share mutually beneficial information. Electronic bulletin boards are also gaining popularity. CompuServe offeers a board service that carries messages and correspondence through the medical field. Data bases are being developed which will provide references on specific medical subjects. GTE's Socio/Economic Bibliographic Information Base(copywright 1982, American Medical Association) lists references from over 700 journals on topics such as public health, psychology, medical practice and ethics, and education.

Dr. Mathew Cushing, a physician associated with Lawrence General Hospital, Lawrence MA, has developed a computerized disease index to get listings of all abnormalities associated with diseases he is currently treating. Similarly, GTE has installed Disease Information and Drug Information databases in the staff lounges of several of the hospitals affiliated with UHCC network.

This paper has attempted to provide some current examples and trends in the advancement of automation in the medical field. It is by no means comprehensive or even totally representative of what strides are being made, or what is currently available. What is presented though, does indicate that data automation within the medical field is current, state of the art, and consistently progressive with data automation advances in general. Additionally, if what Lotfi A. Zadeh of Berkley says about future trends of computer science is correct, the trends seen in the medical community are right on track with automation trends in general. (CACM, Apr 84, p304) Of the three trends Mr Zadeh sees, massing of large data bases and widespread use of artificial intelligence are two that are becoming ever more popular in medical data automation.

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